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ABSTRACT

A desire to foster enduring, positive attitudes toward science teaching among elementary school teachers led to a study of self-perceptions. On the basis of evidence for strong links between locus of control orientation and attitudes, an attempt was made to enhance internality through instruction. A quasi-experimental research strategy was employed to compare the effects of two instructional treatments. Both treatments incorporated strategies known to have positive effects on attitudes, but the experimental treatment was novel in its emphasis on self-management, goal clarification, and individualized course expectations. A significant difference in science locus of control (SciLOC) orientation between groups followed treatment, with subjects exposed to the experimental treatment exhibiting greater internality. Quantitative comprehension and subject age were employed as covariates of SciLOC orientation, and subject sex was employed as a moderator variable. Though the treatment effect is small, accounting for three percent of the variance in SciLOC orientation, control orientation is shown to be susceptible to educational intervention. These results encourage attention to teacher attitudes from a rather new perspective, and they raise several interesting research questions regarding instructional methods and the long term effects of enhancing internality. (Author/JN)

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Evidence That Science Locus Of Control Orientation Can Be Modified Through Instruction

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Abstract

A desire to foster enduring, positive attitudes toward science teaching among elementary school teachers led to study of self-perceptions. On the basis of evidence for strong links between locus of control orientation and attitudes, an attempt was made to enhance internality through instruction.

A quasi-experimental research strategy was employed to compare the effects of two instructional treatments, with pretest measures being used to check the initial equivalence of treatment groups, and analysis of covariance (ANCOVA) being used to test treatment effects. Both treatments incorporated strategies known to have positive effects on attitudes, but the experimental treatment was novel in its emphasis on self-management, goal clarification and individualized course expectations.

There was found by ANCOVA to be a significant ($p \leq .05$) difference in science locus of control (SciLOC) orientation between groups following treatment, with subjects exposed to the experimental treatment exhibiting greater internality. Quantitative comprehension and subject age were employed as covariates of SciLOC orientation, and subject gender was employed as a moderator variable. Though the treatment effect is small, accounting for 3% of the variance in SciLOC orientation, control orientation is shown susceptible to educational intervention. These results encourage attention to teacher attitudes from a rather new perspective, and they raise several interesting research questions regarding instructional methods and the long term effects of enhancing internality.

Introduction

The need remains great to identify strategies which foster enduring, positive attitudes toward science teaching among elementary school teachers. The amount of science taught and the way science is taught in our schools are primarily determined by what individual teachers believe, know, and do (DeRose, Lockard, & Paldy, 1979; Harms, 1981), and attitudes shape teacher behavior ir the classroom (Oliver & Taylor, 1980). Of crucial importance are some attitudes based on notions teachers have about themselves, for Goodlad (1984) provided evidence that elementary teachers commonly perceive themselves poorly prepared to teach science, and reluctance to teach science seems often based on self-conceptions (Shymansky & Green, 1982). In the search for factors influencing attitudes, researchers have studied the contributions of personal

science knowledge, skill proficiency and experience, but have given comparatively little attention to dimensions of personality such as beliefs or self-conceptions which likely influence attitudes (Morrisey, 1981).

After reviewing literature pertaining to teacher traits and characteristics, Kremer and Hofman (1979) identified three personality dimensions as being most relevant to studies of instructional performance: (a) cognitive and affective orientations toward classroom processes, (b) degree of open-mindedness in beliefs, and (c) locus of control orientations. The much-studied locus of control (LOC) dimension of personality seems an area of particular interest given evidence that internality is positively related to a sense of well-being (Hill, 1978) and self-esteem (Prawat, Grissom, & Parish, 1979), and negatively related to anxiety (Bar-Tal, Kfir, Bar-Zohar, & Chen, 1980). Preliminary work with a science locus of control (SciLOC) construct has also provided evidence that a strong, positive relationship exists between SciLOC internality and attitudes toward science teaching (Haury, 1984b).

An assumed benefit of increased internality is increased success as a teacher. Scheck and Rhodes (1980) found highly internal junior high school teachers tending to be rated higher than associates by observers asked to evaluate teaching competence. The evaluation instrument used to measure competence included items ranging in focus from classroom management to creativity in teaching.

Also of interest is an earlier study by Murray and Staebler (1974) who examined relationships among student gender, teacher LOC orientation, student LOC orientation, and student achievement. Achievement was expected to be most strongly related to student gender or LOC orientation, with internals exhibiting greater gains than externals. The major finding, however, was that

student achievement was most strongly related to teacher control orientation, with achievement being positively related to teacher internality. In this instance, then, a teacher characteristic is shown more strongly related to student performance than either of the two student characteristics studied. On the basis of these and other findings related to control orientations, it seems to me worthwhile exploring the possibility of enhancing SciLOC internality among elementary teachers through instruction.

Instructional elements having been examined for their effects on general LOC orientation include classroom structure (Bar-Tal, Leinhardt, & Bar-Tal, 1978), student responsibility for learning (Matheny & Edwards, 1974; Grandy, 1978), classroom flexibility (Wang & Stiles, 1976), self-management (Arlin & Whitley, 1978; Frank, 1980), and personal setting of goals (Gaa, 1979; Schafer, 1981; Johnson & Bukacek, 1979). Though results have been mixed from these efforts, Frank (1980) reported strong evidence that strategies emphasizing student self-management can foster internality. In nonschool settings, goal clarification techniques have also been demonstrated effective in promoting internality (Beatty & Gardner, 1979; Gardner & Beatty, 1980), but such techniques have been less effective in school settings (Gaa, 1979; Schafer, 1981; Johnson & Bukacek, 1979). The mixed results gained from these efforts have been disappointing, but instructive none-the-less.

Inconsistent results from attempts to increase internality through instruction may reflect an ineffective combination of treatment and measurement strategies. Most instructional treatments have been rather unidimensional in nature, and control orientations have been assessed using general measures. In a sense, general LOC orientation is demonstrated by the many ineffective treatments to be a relatively stable personality factor which will likely not be significantly altered by brief exposure to one subtle instructional

technique. As Anshel (1979) has suggested, changes in LOC orientation in response to instructional treatment can be expected only when subjects experience prolonged and frequent exposure to treatment conditions, and when subjects perceive the requisite tasks to be important and meaningful.

For this study, then, a multidimensional treatment strategy was implemented, and, following the suggestions of Rotter (1975) and Lefcourt (1976), an area-specific instrument was used to assess control orientations. It was hypothesized that an instructional treatment emphasizing self-management, personal responsibility, and personal goal-setting in situations involving science or science teaching will promote increased internality, with subjects who are exposed to the treatment exhibiting greater SciLOC internality than peers who experience more traditional instruction.

Methodology

Subjects

Subjects of this study were students in a science methods course for prospective elementary teachers. Of 112 students composing four sections of the course, 108 were consenting subjects--91 females and 17 males. Due to subject mortality and incomplete participation by some subjects, the effective sample was reduced to 98, or 90.7% of those consenting. A more complete statistical profile of the research sample has been presented elsewhere (Haury, 1984a).

Research Design

The investigation spanned two academic quarters, with two class sections being studied concurrently during each quarter. A quasi-experimental design was employed to compare the effects of instructional treatment, and, using Campbell-Stanley notation, the design can be represented as follows:

Key

$O_1\ X_1\ O_2\ O_3$

$O_4\ X_2\ O_5\ O_6$

X_1, X_2 = Treatments

O_1, O_4 = SciLOC pretest (LOCIS I Scale)

O_2, O_5 = SciLOC posttest (LOCIS II Scale)

O_3, O_6 = LOC posttest (I-E Scale)

The use of intact class groups brings into question the effects of subject self-selection and other threats to the study's internal validity. Selection bias was controlled in four ways: by cross-pairing the four class sections to form two treatment groups, by randomly assigning treatments to the two groups, by administering a SciLOC pretest to demonstrate initial equivalence between groups, and by comparing groups using organismic, demographic, and academic variables possibly having an effect on control orientation. Using analysis of variance (ANOVA) to test group differences among consenting subjects, no significant deviation from a random distribution of values was detected for gender, ethnicity, age, initial SciLOC orientation, or quantitative comprehension as measured by the California Achievement Test (see Appendix A, pages 20-29).

In comparing consenting subjects with those not consenting and those not fully cooperative in responding to instrumentation, there were two biases noted. The proportion of nonwhite subjects declining to participate in the study, or failing to fully cooperate, was significantly ($p \leq .05$) greater than that of white subjects (see Table A of Appendix A, page 20). Also, subjects who cooperated fully in the study significantly ($p \leq .05$) outperformed the others on the science methods course quizzes (see Table I of Appendix A, page 29). Comparisons of the two groups in terms of methods course grades, high school grade point average, and total credit hours of college mathematics and

science coursework, however, yielded no other indication of significant differences in academic performance.

Because of the comparatively few nonwhite subjects (n = 19 of 112) and the small percentage of nonconsenting (3.6%) and not-fully-cooperative (8.9%) subjects, these biases were not considered serious threats to validity, but caution must be exercised in interpreting any contribution of ethnicity to the results. The preponderance of evidence from comparisons shows treatment groups to be essentially equivalent in subject composition and consenting subjects to be adequately representative of the population of interest.

Instrumentation

Two forms of the 18-item Locus of Control in Science (LOCIS) Scale (Haury, 1984a,b) were used to measure SciLOC orientation, with the pretest version (LOCIS I Scale) having items with a dyadic, forced-choice format, and the posttest version (LOCIS II Scale) having items with a five-point Likert scale format. The two versions exhibited internal consistencies (Cronbach's alpha) of .73 and .75 respectively with the subjects of this study.

Rotter's (1966) I-E Scale was employed to measure general LOC orientation. This scale has been used extensively to estimate generalized LOC orientation, and performance norms have been reported for a great variety of groups (Lefcourt, 1976). Reports of internal consistency range from .65 to .79, depending on the formula used and the group being tested. Among subjects of this study a reliability of .74 was realized.

Instructional Treatments

For descriptive purposes, the treatments can be characterized as comprising two interrelated components--a practicum and a classroom clinic. The practicum experiences were similar for the two groups, with all subjects

expected to teach an experiential science lesson in a field classroom and submit a lesson plan for review sometime during the academic quarter. A teaching assistant (TA) was available to all subjects for consultation upon request, and subjects were encouraged to met with the TA to discuss their field experiences. In conjunction with the field experience, subjects in the traditional treatment group were required to submit a lesson plan, a written analysis of the lesson plan, and a self-appraisal of performance following presentation of the lesson. No practicum report was required of subjects in the experimental treatment group, but they were required to meet with the TA briefly on three occasions to clarify concerns regarding science teaching; to seek support in developing, teaching, and evaluating a specific science lesson; and to assess progress in accomplishing a personally-selected instructional goal. In many respects, the practicum component of the experimental treatment resembles the origin training described by de Charms (1981).

The clinical component of treatments did not vary across groups with regard to instructional staff, instructional content during classtime, textbook, quizzes, or number of sessions. The clinic experiences for all subjects included several features empirically demonstrated to promote postive attitudes toward science teaching. These include an emphasis on field experience (Piper & Moore, 1977); an emphasis on the process skills of science (Horner, 1975; Kennedy, 1973); the use of materials and strategies which teachers can later use with children (Bratt, 1977); and use of approaches endorsed by major curriculum projects (Bratt, 1973). To these features, the experimental treatment of this investigation adds some elements which are intended to promote SciLOC internality.

The differences between treatments were confined to course requirements and the basis for determining grades. Subjects in the experimental treatment were required to select course goals--the grades sought, professional concerns to resolve, etc.--and the means by which goals would be achieved. There were some set requirements, however, including performance above the cutting score (75%) on course quizzes, completion of some assignments required of subjects in both treatment groups, completion of a specified number of personal action exercises, and completion of a specified number of professional growth activities. The latter two requirements refer to out-of-class activities not directly tied to course content; they were intended to extend the influence of the science methods course beyond classtime, to foster student-directed learning, and to make very explicit the relationship between behavior and progress toward goals.

The personal action exercises were intended to promote a sense of personal efficacy through specific actions, visualization techniques, and conceptualization techniques. The focus of the professional growth activities, however, was on awareness of local resources, interpretation of classroom behavior, and clarification of classroom roles, activities hoped to foster personal responsibility as a teacher, role clarification, and awareness of a professional network of support. For examples of these activities, see pages 34-39 in Appendix B.

The variable being manipulated within the clinical component of the course, essentially, was the situational context of course experiences. For the traditional treatment, the focus in meeting course requirements was on gaining an understanding of concepts and developing competence with inquiry process skills which were emphasized during clinic sessions. With the

experimental treatment an attempt was made to modify the context of the same instructional content so the focus would be on using clinic sessions and course requirements to achieve personally-selected goals. Expectations in terms of student time-commitement, student productivity, and academic standards were comparable for both treatment groups, and the reward--course grades--remained the same. (see Appendices B, pages 30-45, and C, pages 46-48, for course syllabi)

Data Analysis

The effects of treatment were first assessed using a fixed-effect ANOVA model. Given the relative novelty of both the theoretical construct involved and the instrumentation, a level of $p \leq .05$ was used to test the null hypothesis of no significant difference due to treatment. Since LOC has been shown to be a relatively stable orientation, and since so many factors have been shown to influence control orientation, it was anticipated that small effects on SciLOC orientation due to treatment may be masked by moderating variables. In the event of no significant difference, then, the strategy was to maximize statistical power by using correlates to control orientation in an analysis of covariance (ANCOVA). The techniques used to analyze variance and covariance are those of the SPSS (Nie, Hull, Jenkins, Steintrenner, & Bent, 1975) subprogram ANOVA as modified for use with a Cyber 750 mainframe computer.

Results

Upon comparing treatment groups with regard to LOCIS II Scale performance, a difference was found between groups (see Table 1), but the difference is not statistically significant (see Table 2). Because quantitative comprehension, subject age, and subject gender had been identified as contributors to SciLOC orientation (Haury, 1984b), they were employed as

Table 1

Breakdown of Scores on the LOCIS II Scale

Group	n[a]	M[b]	SD[c]
Entire Sample	102	50.76	6.98
Treatment A[d]	51	50.06	5.60
Treatment B[e]	51	51.47	8.13

Note. Six cases were missing, which represents 5.6% of the consenting subjects.

[a] n = number of subjects responding to all items.

[b] M = mean value.

[c] SD = standard deviation.

[d] Comparison treatment.

[e] Experimental treatment.

covariates in an ANCOVA design. As shown by Table 3, ANCOVA revealed a significant treatment effect, $F(1, 88) = 3.82$, $p \leq .05$.

To insure that this effect is not an artifact of initial group differences, performance on the LOCIS I Scale, the pretest, was analyzed in the same fashion using ANCOVA. As shown by Table 4, there is no significant difference in LOCIS I Scale score due to treatment group membership, but there is an effect due to gender. It is interesting to note that the gender effect is not found in the analysis of posttest LOCIS II Scale performance, nor is there a significant effect due to the interaction of treatment and gender.

In an effort to estimate the magnitude of the treatment effect on SciLOC orientation, the Omega-squared statistic (Good & Fletcher, 1981) was computed.

Table 2

Test for a Difference in LOCIS II Scale Performance Between Treatment Groups Using ANOVA

Source of Variance	SS[a]	df[b]	MS[c]	F[d]	p[e]
Between Groups	50.82	1	50.82	1.04	.31
Within Groups	4875.53	100	48.76		

[a] SS = sum of squares.

[b] df = degrees of freedom.

[c] MS = mean square.

[d] F = F-ratio.

[e] p = probability or level of significance.

As shown by Figure 1, Omega-squared equals .03, so the treatment effect accounts for approximately 3% of the variance in LOCIS II Scale score.

The I-E Scale was also administered as a posttest to check general LOC orientations. As shown by Table 5, no significant differences between groups were noted.

Discussion

Due to the novelty of the SciLOC construct, the LOCIS Scale, and the experimental treatment, the research plan was designed to maximize the chances of observing a shift in SciLOC orientation, a shift that was detected using ANCOVA. The multidimensional nature of the treatment prevents advocating specific instructional techniques as particularly effective in modifying control orientation, but some inferences can be made. Techniques embedded in the treatment include: (a) the setting of personal learning objectives, (b) guidance in reaching personally-selected goals, (c) a contractual grading scheme, (d) completion of activities which help clarify notions related to

Table 3

Test for a Difference in LOCIS II Scale Performance Between Treatment Groups Using ANCOVA

Source of Variance	SS	df	MS	F	p
Subject Age	525.42	1	525.42	13.00	.001
QCAT[a]	325.77	1	325.77	8.06	.01
Treatment Group	154.58	1	154.58	3.82	.05
Subject Gender	14.69	1	14.69	.36	.55
Treatment Group X Gender	.02	1	.02	.00	.98
Explained	932.76	5	186.55	4.62	.001
Residual	3355.20	83	40.42		
Total	4287.96	88	48.73		

Note. Based on 89 cases, 82.4% of the consenting sample.

[a]QCAT = score on the quantitative portion of the California Achievement Test.

personal instrumentality, and (e) a criterion-level testing procedure. Providing such experiences along with traditional science methods instruction seems to enhance among students a sense of personal agency, or control, in science.

Whether the effect is educationally significant depends on one's perspective. With 97% of the variance in SciLOC orientation being explained by factors other than exposure to treatment, the experimental treatment cannot be promoted as a general model for science methods course instruction, but from a perspective of basic research the effect takes on greater significance. The concerns elementary teachers express regarding their own competence in science

Table 4

Test for a Difference in LOCIS I Scale Performance Between Treatment Groups Using ANCOVA

Source of Variance	SS	df	MS	F	p
Subject Age	59.66	1	59.66	5.80	.02
QCAT	31.18	1	31.18	3.03	.09
Treatment Group	6.54	1	6.54	.64	.43
Subject Gender	39.23	1	39.23	3.82	.05
Treatment Group X Gender	.10	1	.10	.01	.92
Explained	130.00	5	26.00	2.53	.04
Residual	832.66	81	10.28		
Total	962.65	86	11.19		

Note. Based on 87 cases, 80.6% of the consenting sample.

$$\text{Omega}^2_{est} = (SS_t - (df)(MS_e))/(SS + MS_e)$$

SS_t = Treatment sum of squares

df_t = Treatment degrees of freedom

MS_e = Error mean square

SS = Total sum of squares

$$\text{Omega}^2_{est} = (154.58 - (1)(40.42))/(4287.96 + 4012)$$

$$= .03$$

Figure 1. Computation of Omega-squared

Table 5

Test of Group Differences in I-E Scale Performance Using ANOVA

Source of Variance	df	MS	F	p
Treatment Group	1	3.20	.21	.65
Methods Course Section	1	.82	.05	.82
Academic Quarter	1	.09	.01	.94
Class Membership	3	1.82	.12	.95
Subject Gender	1	9.84	.65	.42
Subject Ethnicity	1	13.15[a]	.92	.34

Note. Total sum of squares equals 1177.95 with 78 degrees of freedom except where noted otherwise.

[a]Total sum of squares equals 987.84 with 69 degrees of freedom.

and their reluctance to teach science may reflect SciLOC orientations, orientations that seem susceptible to modification through techniques that can be built into the structure of courses without requiring radical changes in the actual delivery style of instructors. Though seemingly weak, the effect is sufficiently tantalizing to warrant more powerful and refined study. Beyond the continual search for powerful instructional techniques supported by empirical evidence, there is the need to consider the cumulative effect of strategies implemented consistently over a period of time in a variety of science-related courses. Rowe (1974a,b), for instance, has convincingly demonstrated how simple techniques consistently applied over time can have profound effects on learning.

There is also the need to determine whether changes in SciLOC orientation have any verifiable and lasting effect on actual classroom behavior. Within an

educational context, the merit of attending to SciLOC orientation must ultimately be decided within the classroom. Awareness of a significant relationship between expressed attitudes and a personality characteristic which can be modified through instruction brings with it an opportunity to address a persistent educational problem from a new conceptual perspective.

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Appendix A: Pretest Comparisons of Treatment Groups

Table A

Chi-square Analysis of Subject Distribution According to Gender and Ethnicity

	Gender		Ethnicity	
Grouping Category	Chi^2	p[a]	Chi^2	p
Group Membership				
Course Section (A vs B)	.28	.60	2.51	.11
Academic Quarter (Fall vs Winter)	.40	.53	1.57	.21
Treatment Group (A vs B)	.28	.60	1.65	.20
Participation in Study				
Consent Status (consenting vs nonconsenting)	.02	.88	7.99	.00
Degree of Participation (complete vs partial)	.01	1.00	4.57	.03

[a] p = probability that Chi-square (Chi^2) value is the result of chance events.

Table B

Breakdown of LOCIS I Scale Scores Among Groups

Category	n[a]	Range[b]	M[c]	CI[d]	SD[e]	SE[f]
Entire Sample	100	3-18	10.97	10.32-11.63	3.30	.33
Treatment A	48	6-17	10.87	9.88-11.86	3.40	.49
Trial 1	15	6-16	9.71	7.92-11.49	3.23	.83
Trial 2	32	6-17	11.40	10.20-12.60	3.39	.56
Treatment B	52	3-18	11.07	10.17-11.97	3.24	.45
Trial 1	19	4-17	11.57	10.00-13.15	3.27	.75
Trial 2	33	3-18	10.78	9.63-11.93	3.24	.59
Course Section A	48	3-18	10.45	9.51-11.39	3.24	.47
Course Section B	52	4-17	11.46	10.54-12.39	3.32	.46
Autumn Quarter	34	4-17	10.75	9.58-11.91	3.34	.57
Winter Quarter	66	3-18	11.09	10.28-11.90	3.30	.41
Male Subjects	14	7-17	12.31	10.38-14.25	3.36	.90
Female Subjects	86	3-18	10.76	10.06-11.46	3.26	.35
White Subjects	73	3-17	11.11	10.35-11.88	3.27	.38
Nonwhite Subjects	16	6-18	10.20	8.51-11.89	3.18	.80

Note. If three or fewer items on the LOCIS I Scale were not completed by a subject, sample means for the missing items were substituted, providing an estimate for total score.

[a] n = number of subjects in category.

[b] Range = extreme lower and upper scores.

Table B--continued

[c]M = mean score for category.

[d]CI = values designating a 95% confidence interval.

[e]SD = standard deviation for the category.

[f]SE = standard error for the category.

Table C

Test of Initial Group Differences in LOCIS I Scale Performance Using Analysis of Variance (ANOVA)

Source of Variance	df[a]	MS[b]	F[c]	p[d]
Treatment Group	1	24.82	1.13	.29
Methods Course Section	1	25.74	2.39	.13
Academic Quarter	1	2.65	0.24	.62
Class Membership	3	12.69	1.17	.33
Subject Gender	1	29.21	2.73	.10
Subject Ethnicity	1	10.95[e]	1.03	.31

Note. Total sum of squares equals 1079.72 with 99 degrees of freedom except where noted otherwise.

[a]df = degrees of freedom.

[b]MS = mean square.

[c]F = F-ratio (variance between groups divided by variance within groups).

[d]p = probability or level of significance.

[e]Total sum of squares equals 931.55 with 88 degrees of freedom.

Table D

Breakdown of Subject Ages Among Groups

Category	n	Range	M	CI	SD	SE
Entire Sample	107	21-40	25.50	24.61-26.40	4.68	.45
Treatment A	52	21-39	26.00	24.63-27.37	4.90	.68
Trial 1	18	21-37	26.06	23.60-28.51	4.93	1.16
Trial 2	34	21-39	25.97	24.24-27.70	4.97	.85
Treatment B	55	21-40	25.04	23.83-26.24	4.46	.60
Trial 1	22	21-40	25.86	23.65-28.08	5.00	1.07
Trial 2	33	21-35	24.48	23.05-25.92	4.04	.70
Course Section A	51	21-37	25.04	23.80-26.27	4.39	.61
Course Section B	56	21-40	25.93	24.61-27.25	4.94	.66
Autumn Quarter	40	21-40	25.95	24.38-27.52	4.90	.78
Winter Quarter	67	21-39	25.24	24.13-26.35	4.56	.56
Male Subjects	15	23-35	27.53	25.05-30.02	4.49	.49
Female Subjects	92	21-40	25.17	24.21-26.14	4.65	1.16
White Subjects	77	21-39	25.51	24.47-26.54	4.56	.52
Nonwhite Subjects	19	21-40	25.47	22.78-28.17	5.59	1.28

Note. The age of one subject is not known, and the ethnicity of eleven subjects is not known.

Table E

Test of Group Differences in Age Distribution using ANOVA

Source of Variance	df	MS	F	p
Treatment Group	1	24.82	1.13	.29
Methods Course Section	1	21.11	.96	.33
Academic Quarter	1	12.67	.58	.45
Class Membership	3	16.67	.76	.52
Subject Gender	1	71.80	3.35	.07
Subject Ethnicity	1	.02[a]	.00	0.98

Note. Total sum of squares equals 2324.75 with 106 degrees of freedom except where noted otherwise.

[a]Total sum of squares equals 2144.00 with 95 degrees of freedom.

Table F

Breakdown of CAT Mathematics Scores Among Groups

Category	n	Range	M	CI	SD	SE
Entire Sample	99	37-85	70.99	68.89-73.09	10.52	1.06
Treatment A	47	37-85	70.87	67.74-74.00	10.66	1.56
Trial 1	16	52-85	69.88	64.49-75.26	10.11	2.53
Trial 2	31	37-85	71.39	67.33-75.45	11.07	1.99
Treatment B	52	47-84	71.10	68.18-74.02	10.49	1.45
Trial 1	21	54-82	71.95	67.83-76.07	9.05	1.98
Trial 2	31	47-84	70.52	66.31-74.72	11.47	2.06
Course Section A	47	47-85	70.30	67.09-73.50	10.92	1.59
Course Section B	52	37-85	71.62	68.77-74.46	10.21	1.42
Autumn Quarter	37	52-85	71.05	67.91-74.20	9.44	1.55
Winter Quarter	62	37-85	70.95	68.11-73.79	11.19	1.42
Male Subjects	14	50-85	68.57	61.70-75.45	11.91	1.12
Female Subjects	85	37-84	71.39	69.17-73.61	10.29	3.18
White Subjects	73	37-85	71.03	68.53-73.53	10.71	1.25
Nonwhite Subjects	16	49-84	70.56	64.24-76.89	11.87	2.97

Note. The CAT mathematics score is not available for nine subjects, and the ethnicity of another ten subjects is not known.

Table G

Test of Group Differences in CAT Mathematics Scores Using ANOVA

Source of Variance	df	MS	F	p
Treatment Group	1	1.24	.01	.92
Methods Course Section	1	42.85	.39	.54
Academic Quarter	1	.24	.00	.96
Class Membership	3	17.06	.15	.93
Subject Gender	1	95.37	.86	.36
Subject Ethnicity	1	2.84[a]	.02	.88

Note. Total sum of squares equals 10840.99 with 98 degrees of freedom except where noted otherwise.

[a]Total sum of squares equals 10178.72 with 88 degrees of freedom.

Table H

A Six-variable Comparison of Fully Cooperative Subjects With Subjects Who Did Not Cooperate Fully

Variable/Subjects	n	Range	M	CI	SD	SE
Past Performance						
High School Cummulative GPA						
Cooperative	75	1.98-3.97	3.29	3.19-3.40	.46	.05
Noncooperative	12	1.72-3.85	3.21	2.82-3.59	.60	.17
Total Credit Hours of College Mathematics and Science						
Cooperative	93	9-249	30.54	24.23-36.84	30.62	3.18
Noncooperative	14	13-118	31.93	14.08-49.78	30.91	8.26
LOCIS Scale Score Covariates						
Mathematics Subscale Score on the CAT						
Cooperative	86	37-85	71.20	68.90-73.50	71.20	10.73
Noncooperative	13	50-80	69.62	64.04-75.20	69.62	9.23
Subject Age						
Cooperative	93	21-40	25.55	24.56-26.53	4.78	.50
Noncooperative	14	21-36	25.21	22.83-27.60	4.14	1.11

Table 7 (continued)

Variable/Subjects	n	Range	M	CI	SD	SE
Current Performance						
Performance on Science Methods Course Quizzes						
Cooperative	98	124-195	173.46	170.84-176.08	13.05	1.32
Noncooperative	13	142-186	164.46	156.03-172.90	13.96	3.87
Grade in Science Methods Course						
Cooperative	98	2.1-4.0	3.59	3.50-3.68	.45	.05
Noncooperative	13	2.2-3.9	3.37	3.01-3.73	.59	.16

Table I

Tests of Differences Between Subjects Who Cooperated Fully in the Study and Those Who Did Not, Using ANOVA

Source of Variance	df	SS[a]	MS	F	p
High School Cumulative GPA					
Between Groups	1	.08	.08	.35	.55
Within Groups	85	19.90	.23		
Total Credit Hours of College Mathematics and Science					
Between Groups	1	23.54	23.54	.03	.87
Within Groups	105	98696.05	939.96		
Mathematics Subscale Score on the CAT					
Between Groups	1	28.27	28.27	.25	.62
Within Groups	97	10812.72	111.47		
Subject Age					
Between Groups	1	1.36	1.36	.06	.80
Within Groups	105	2323.39	22.13		
Performance on Science Methods Course Quizzes					
Between Groups	1	929.19	929.19	5.37	.02
Within Groups	109	18865.57	173.08		
Grade in Science Methods Course					
Between Groups	1	.54	.54	2.51	.12
Within Groups	109	23.37	.21		

Note. Group membership in all cases is based on degree of cooperation (full versus less than full) as a subject.

[a]Total sum of squared deviations.

Appendix B: Experimental Treatment Syllabus

Science Clinic

EDC&I 370: Course Expectations and Grading

In an effort to allow you flexibility in pursuing personal objectives while satisfying my criteria for assigning grades, I have devised a contractual grading system. You decide which grade you desire (2.3, 2.8, 3.3, or 3.8) amd complete the tasks required to obtain that grade. I will evaluate your performance on each task as objectively as possible and assign a grade within two decimal units of the grade for which you have contracted. For instance, if you desire a grade near 3.8, you will be assured of a final grade in the range of 3.6 to 4.0 if you complete all of the requirements. When all of the requirements have been completed, attach the written materials together, add a cover page which states the grade you desire, and submit the package for assessment anytime before December 1, 1981.

Contract Levels

Level 2.3 requirements:

1. Attend class regularly and punctually
2. Complete reading assignments in the course textbook
3. Obtain a score of at least 75% on each course quiz (repeated attempts will be permitted)
4. Complete the Field Practicum requirement (outlined in detail on a separate handout)

Level 2.8 requirements:

1. Complete the requirements for level 2.3
2. Continue at least one Personal Action exercise during the quarter
3. Complete at least one Professional Growth Activity
4. Complete the Science Program Review Assignment

Level 3.3 requirements:

1. Complete the requirements for level 2.3
2. Continue at least two Personal Action Exercises during the quarter
3. Complete at least two Professional Growth Activities
4. Complete the Science Program Review assignment
5. Complete the Article Application assignment

Level 3.8 requirements:

1. Complete the requirements for level 2.3
2. Continue at least two Personal Action Exercises during the quarter
3. Complete at least three Professional Growth Activities
4. Complete the Science Program Review assignment
5. Complete the Article Application assignment
6. Complete the Science Education Advocate assignment

Assignment Descriptions

Quizzes. There will be four or five quizzes covering the topics addressed in class and in the textbook readings. The emphasis will be on using developed skills to solve problems and on applying principles and concepts in realistic situations. The best preparation for these quizzes will be active class involvement. You will be allowed to repeat portions of a quiz that you find difficult until the desired score is achieved.

Field Practicum. In the classroom where you are assigned as an intern, you will be expected to teach a science lesson sometime during the quarter. Prior to teaching the lesson, you will be expected to meet with the teaching assistant, once as part of a small group and once privately. Sometime after the lesson, you will once again meet with the teaching assistant to evaluate the experience. It will be necessary for you to schedule these conferences with the teaching assistant well in advance. Details concerning the practicum experience will be provided on a separate handout titled "Field Practicum Guidelines".

Personal Action Exercises. These brief but routine exercises are specifically intended to help you accomplish two things: (1) construct a clear idea in your own mind as to how you might best teach science and (2) avoid unnecessary stress in educational settings. The exercises are not expected to be easy solutions to difficult problems, but are positive actions that may help you develop your own skills of managing tension. Hint: these exercises are likely to help you only if you are consistent in performing them. Please try. You will find the exercises listed on a separate page of this handout.

Professional Growth Activities. An effective teacher continually seeks out local resources, takes advantage of professional activities, attempts to learn more about students, and keeps abreast of trends and developments in education. From the alternatives listed on a separate page of this handout, select experiences that will help you grow professionaly in some of these areas. A short written response (not to exceed one page if typed) of each experience will be submitted for evaluation.

Science Program Review. Use the guidelines of chapter 9 in your textbook, particularly pages 270-277, to evaluate three science programs, the one used in your school and two other programs which are not analyzed in chapter 9. Refer also to the handouts provided in class. If any of the programs have a textbook, use the attached rating form provided in class or one of your own design to evaluate the textbook separately. Summarize your findings in writing (no more than one page if typed), and attach the rating forms that you used.

Article Application. For this assignment you will be encouraged to develop your own science lesson from information included in one or more published articles. The article can be teacher-oriented such as those found in Science and Children, or it can be more content-oriented such as those found in Science News, National Geographic, or similar. The object of this task is to give you some experience in modifiying readily available information into a lesson format. It is strongly suggested that you choose a lesson topic and objective that could supplement the science program in your school. Are your students doing something in science right now that could be extended by infusing the ideas gleaned from a journal article? You do not have to teach this lesson (though you are encouraged to do so!), but you must construct a lesson plan using the simple form attached to this handout. The form intentionally lacks structure so that you may supply the detail in a format that is most functional to you. Submit the completed form, being careful to include a reference to the article (author, title, journal, issue) in the "Materials" section. On the back of the form you are encouraged to add any additional information that will help you teach the lesson at some later date in your career, or information you think will help me interpret your plan.

Science Education Advocate. Though I feel strongly that science is basic to a well-rounded education, I realize that other teachers, administrators, and parents do not share my convictions. In your future teaching assignments, you will want to be able to justify any emphasis you give to science education. In this assignment you will be asked to assume that you have five minutes to respond to either a parent or an administrator who questions the emphasis you give science in your classroom. You will prepare and deliver orally on cassette tape your response. Begin your recording by stating: (a) who you are, (b) whether you are responding to a parent or an administrator, and (c) the grade level of your imaginary students. Then allow yourself five minutes to justify your emphasis on science. For some ideas on what arguments to use, refer to your textbook, talk with your clinic classmates, and ask some teachers that you know who do place an emphasis on science. If you need to borrow a cassette tape or use one of our recorders on campus, talk to the teaching assistant.

HINTS ON HOW TO COPE WITH THESE TASKS

1. Decide very soon what grade you want to work for and design a checklist for yourself. Include on the checklist all of the requirements for the grade you desire and list the options that you will complete to satisfy each requirement. Refer to the list regularly and check off each task as it is completed.

2. Select the options that best meet any personal needs or interests that you have; avoid selecting options just because they seem easier for you than do some of the others.

3. Complete the items in a way that will benefit you now and in the future, as if you were developing personal resource materials.

4. Budget your time. The weakness of contractual grading systems is that procrastination can be accommodated! Progress through the requirements methodically, setting your own deadlines and standards. Take advantage of the flexibility to avoid end-of-the-quarter blues.

Personal Action Exercises

The exercises selected should be continued throughout the quarter. React in writing to your experience, limiting your response to the equivalent of one typed page for each experience. Was the exercise of any personal value? What were the effects? Any disappointments?

1. Everyone is occasionally interrupted by the telephone. Deliberately avoid answering the telephone twice each week when you are involved in some self-planned task and are not expecting an important call. Whenever you feel the need to respond to a situation with anxiety, say to yourself, "I am letting the telephone ring".

2. Recall specific situations in the past when you had a positive experience and science was the focus. What were you doing? Who was involved? What was the topic? Spend five to ten minutes to construct a mental image of the situation. Do this exercise three times a week while the supply of specific situations last. You may need to keep a list so you do not repeat experiences. When you can no longer recall additional situations, imagine situations that you would find enjoyable and interesting if the opportunity arose.

3. Imagine a classroom in which you would feel comfortable teaching science. Think about what is in the room, what the students are doing, and what you are doing. Try to "feel" the situation emotionally. What would make you feel glad? This may be difficult at first, but work at making it come easier. Mentally retreat into this same room at least once each day for several (5?) minutes--maybe before you arrive at your field experience--to reflect on what is happening there and to gradually make the mental image of the situation as specific as possible. If you ride the bus, do it then.

4. Buy a cheap notebook of a convenient size to take wherever you go, and provide yourself with the most satisfying line-maker you can find. Make drawings for yourself in this notebook for the next few weeks while you are involved in trying to understand a difficult concept or trying to solve a problem. Your drawings may be doodles, block diagrams, schematics, squiggles, sketches, or whatever seems appropriate to you. Try to find out which of these drawings help your understanding and which do not. Does a lack of drawing skills matter much? Do you use your notebook to refer to previous work? Does the size of your notebook inhibit you?

5. Develop the best one-page list of characteristics you can of a model elementary school science teacher. Observe role models, talk to classmates, talk to students, recall your own experiences, seek clues in your reading of the textbook or journal articles, and consider the nature of children. Start right away and refine your list routinely each week during the quarter. Continually seek to improve and make explicit the description. Once you have your list finalized, use parentheses to add negative alternatives after each listed characteristic. That is, what alternative characteristics would the model elementary school science teacher not have?

6. Seeking potential conflicts among your beliefs, self-concept, and commitments. Over a period of time, work through the following sequence one step at a setting.

(a) List five thing you most want to accomplish with regard to teaching science (goals).
(b) List three things you like most about teaching science.
(c) List three things you dislike most about teaching science (stressors).
(d) List three things you like most about yourself.
(e) List three things you dislike most about yourself.
(f) Examine the three things you dislike most about teaching science (c) and determine whether or not they are essential to achieving the things you most want to accomplish with regard to teaching science (a).
(g) Examine the three things you dislike most about yourself (e). Do any of these conflict with those things you most want to accomplish with regard to teaching science (a)?
(h) Is there a relationship between the things that stress you and the goals you have set for yourself?
(i) Are the goals (a) and the good things about yourself (d) and teaching science (b) worth the stress caused by (c) and (e)?
(j) Are any of the stressors (c) and (e) overstated? Is there action you could take to reduce their effect? Can goals be reassessed to increase the potential of your happiness in teaching science?

7. Try the "Recipe for Relaxation" which is described on the following page.

RECIPE FOR RELAXATION

1. Close your eyes, forget anyone or anything that is physically near you. (This may work better if you are alone.)

2. Create for yourself an ideal place. Decide:

* What it looks like.
* Colors, sizes, shapes.
* Whether it is indoors or outdoors, in the city or country, in the mountains, on the beach, on a cruise ship. (It may be a place you've been before or it may be one you've dreamed of.)
* Who else is there. (If you relax well with someone else, bring that person into your space.
* What you are doing (sitting, walking, playing, eating, drinking, listening to music, soaking in a hot tub).
* What you are wearing (whatever is most comfortable, makeup or no makeup, hair done or undone).

3. Now that you have the place you can enjoy, the person (if any) you want, the clothes, the colors, food or drink, start to relax the mind. You can do this because you have everything you want right there. You are not thinking about tomorrow. As far as you are concerned, today will go on for as long as you like. Whatever you do next, you will do because you want to do it.
Now examine all your muscles to see if each is beginning to relax. If not, let your mind wander over to that muscle. Tense it, hold it for a second, then allow it to relax.

4. Enjoy your space.

5. Practice this routine once daily for 10-20 minutes, maybe the last thing before going to bed at night or at the end of your workday.

From:
Muse, J. Survival of Stressed Teachers. Steps for managing stress and preventing burnout. Washington, D.C.: National Education Association of the United States, 1980.

Professional Growth Activities

(Note: Written reports for the various activities should not exceed one page in length)

1. Attend the Environmental Education Workshop at Cornet Bay and react in writing to the experience. Evaluate the experience. Was it worth your time? What did you most like or dislike about the experience? Did you gain any practical information from the workshop?

2. Visit two community resources such as the Chittenden Locks on the Lake Washington Ship Canal in Ballard, Carkeek Park, the Public Market at Pike Place, the University's Arboretum, or similar to assess how such facilities could be used to enrich science instruction in the elementary school. Is the site useful for field trips? Why or why not? What problems would be associated with using the site? What topics or concepts would you try to develop at such a site? What would you actually do at the site?

3. Visit a community resource having an educational program or interpretive materials, such as Woodland Park Zoological Gardens, the Seattle Aquarium, the Pacific Science Center, The Thomas Burke Museum, or Discovery Park, and find out specifically what support they can provide to you as a teacher (such as programs, kits, exhibits, tours, speakers, etc.). View their facilities and exhibits, and obtain a copy of any relevant printed materials they provide. Contact their education director by telephone to seek information about services to teachers. React in writing to the visit and attach any materials you may have collected. Do the resources seem potentially useful to you as a teacher?

4. Contact two of the following three agencies to find out what services they can provide you as a teacher of science in the elementary school. Describe their services and attach any printed materials you receive.
Seattle City Light - Pat Robertson (625-3543)
City Water - Mike Mercer (625-5674)
Pacific Museum of Flight - Georgia Franklin (622-3972)

5. Visit the resource center of your school district or the nearect Educational Service District (such as ESD 121 at 1410 S 200th in Seattle, telephone number 242-9400) in order to find out what kinds of services and materials they have available to support science instruction in the elementary school (books, equipment, charts, games, audio-visual materials, etc.). Evaluate the resources and attach any printed listing or descriptions of available materials. What things are not available that you think ought to be?

6. Develop a simple observation instrument that your Field Associate (F.A.) can use to provide some specific feedback that you desire about your science instruction in the classroom. Use ideas presented in chapter 8 of the textbook (Trojcak, Science With Children) or look at examples in other books you may read about instruction. This is an opportunity for you to find out some specific information that you want to know about yourself. Have your F.A. use the instrument while you teach and react in writing to the experience. Include a copy of the instrument you develop. Challenge: Have your F.A. use the instrument while you are implementing an activity-oriented lesson.

7. Review a book on science teaching that gives information on topics not treated in our textbook. Loving and Beyond: Science teaching for the Humanistic Classroom or Creative Sciencing: A Practical Approach are good ones to look at. There are others in the library, including one by Mary Budd Rowe (Teaching Science as Continuous Inquiry) which are very valuable resources. Does the book supply any new information that seems helpful? What is the most practical idea that you found in the book? Are there topics which seem important to you that none of the books address?

8. Set up a "science activities corner" in your classroom. There are several resource books on reserve and in the resource room that will provide you with some good ideas. Take a photograph of students using the learning center and briefly describe how it worked and students' reactions.

9. Develop a detailed list of ways you can keep current in science and science education. Mention specific media, journals, organizations (local and national), community resources, or programs that will aid you as a teacher to both develop appropriate science lessons and units, and increase your awareness of science-related issues.

10. Do you have opportunity to work with some handicapped students? Develop a le son for them which promotes one or more of the thinking sk lls presented in chapters 4, 5, 6, and 7 of Trojcak, Scie ce With Children. Hand in your lesson plan and indicate how it has been modified for use with students having a particular handicap. What problems do you anticipate? How will you determine whether or not the lesson is a success?

11. Do you have opportunity to work with some gifted students? Develop or modify a lesson for them as described in #10 above.

12. Construct a teaching aid (task cards, piece of equipment, puzzle, or etc.) to use with a specific lesson or learning center. Refer to sourcebooks on reserve or in the resource room for ideas. How do you use the aid in a lesson? How well does it work? What modifications seem in order? Show your teaching aid to someone to get their feedback. Describe your findings.

13. Perform encounter #2 on page 20 of Trojcak, Science With Children, and report your findings. Include at least three teachers and consider including a prinipal or other administrator.

14. Respond to encounter #6 on page 39 of Trojcak, Science With Children, or to encounter #9 on page 73 (or a combination of both) as they pertain to teaching science in the elementary school.

15. Use the information on pages 48-62 of Trojcak, Science With Children, to actually conduct some clinical interviews that include Piagetian-type conservation tasks. Select a small number of tasks, interview one or more students, and interpret your findings. Respond in writing to encounter #5 on page 73. Also describe your interview.

16. Read four journal articles related to teaching science or teaching activity-oriented lessons. At least one of the articles should be from Science and Children, but none of the articles should be about specific lessons or activities. That is, you should read articles that discuss in general terms the rationale, problems or techniques associated with some aspect of science teaching. React in writing to the articles; please do not merely summarize what you read. Were the articles of any value to you? What did you learn? How will the information in the articles affect your teaching?

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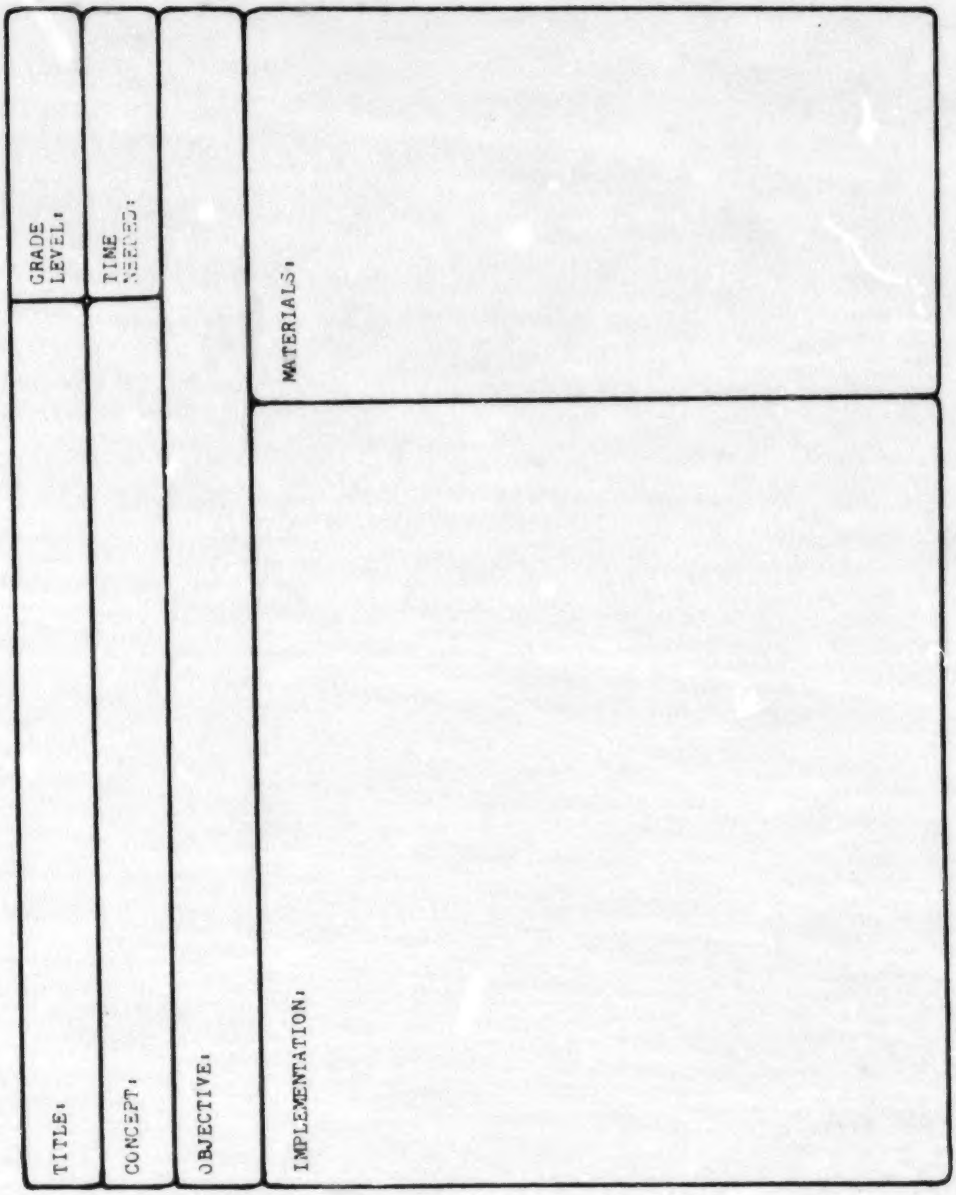

DEVELOPED BY:

Field Practicum Guidelines

1. You will be expected to plan, teach, and evaluate a science lesson in your classroom. It is highly recommended that you choose a topic found in the science program adopted by your school district. If the school does not have a science program, you may want to choose a topic that is related to work you are doing in social studies or some other content area. Try to pick something that will be enjoyable for you as well as for your students.

2. Prior to teaching the lesson, I will meet with you on two occasions: once in a small group setting of five to eight interns, and once privately. Each conference will last about twenty minutes unless we agree together to extend the time.

   (a) The first meeting, when we meet as a group, should be scheduled very soon. At this time you will not need to know exactly what lesson you plan to teach, but it will help if you have identified a topic. This first meeting is essentially an orientation session, but a very important one.

   (b) The second conference, between just the two of us, should be scheduled for a time just a few days prior to the day you intend to teach your science lesson. Prior to meeting with me, you are to prepare your lesson plan and review it for completeness. Refer to the attached "Quick Check Lesson Planner" for ideas about what to include in your lesson plan. You may use whatever lesson plan format seems most functional to you, but whatever format you choose, use the attached "Lesson Planning Sheet" to analyze your plan. Do not consider your plan complete until you can answer each question on the sheet; I may ask you some of the same questions when we meet! To help me prepare for our conference, please hand your lesson plan in to me at least one day before we are scheduled to meet, and I will return it to you during the conference. Do be sure to schedule our private conference as soon as possible, preferably by the end of October, so last-minute time conflicts will be avoided.

3. During our second conference, a third conference will be scheduled for sometime after you have taught your science lesson. During the final conference, we will critique your experience and identify some personal goals for you to pursue. The third conference completes the practicum requirements.

The Quick Check Lesson Planner

Subject: Date: Time:

OBJECTIVES

Act:

Object:

Conditions:

Objectives	Action Words
perceive	note, point
relate	group, associate
reproduce	repeat, draw
analyze	divide, separate
apply	use, solve
evaluate	compare, judge
produce	make, write

IMPLEMENTATION/FACILITATION

Method	Grouping	Names/Responsibilities
telling	large	
showing	small	
questioning	individual	
doing		

Motivator

special interests
novelty
problems or puzzles
manipulate objects
competition
other:

Sequence/Names/Acts

Student Activities	Sequence/ Specifics/ Management	Materials
acting out, telling		charts, equipment
answering, computing		films, filmstrips
constructing, reading		games, globe, kit
discussing, drawing		lab, library books
listening, observing		maps, objects
singing, taking notes		models, pencils
writing		paper, pictures
other:		programs, supplies
		recordings, references, textbooks
		workbooks or sheets

Reinforcers

fun, achievement, knowledge of results, praise, approval
marks, stars, tokens, candy, special privileges

EVALUATION/MEANS OF APPRAISAL

informal observation, formal observation, oral exam
student self-appraisal, written exam, other:

Lesson Planning Sheet

A. OBJECTIVES

Student:

1. Expected behavior: Is it specific? Measurable? What level of achievement do you expect?

2. Identification of learner: What is the student's entering level? Will you give a pre-test? Have you considered individual differences? Students with special problems? (ESL students, sight-impaired students...)

3. Conditions under which learning occurs: Are certain pre-lesson skills assumed? (ability to read a thermometer or make and interpret graphs...) Do you have special environmental restrictions? (an open classroom shared with another large group, no access to water...)

4. Validity: Do these objectives lead toward your educational goals? The school's goals? The student's? (Do you know what all these goals are?)

Teacher:

1. Knowledge of material: Do you feel comfortable with the content? What level of expertise do you feel you need to teach this lesson?

2. Personal/professional skills: What skills would you like to work on during this lesson? (use more open-ended, higher level questions; try new methods of getting class attention, group the students in new ways....)

B. IMPLEMENTATION/STRATEGY

1. Motivation: How will you arouse and sustain attention?

2. Pacing/timing/sequencing: Enough material? Too much? Where could you "cut" the lesson if you run out of time? What parts are you not willing to cut?

3. Materials and management: What materials do you need? Need extras? Where will you put the materials? How

will you organize them? How will the students get and return them? When?

4. Learner participation: Is everyone actively involved? What kinds of interaction is there with materials? Peers? Teachers? Are activities varied?

5. Skills: What skills does the lesson emphasize? (sorting, classifying, measuring, predicting, experimenting...) Do your activities support these skills?

6. Potential management problems: What could go wrong? Have you practiced? Can you foresee any discipline problems?

7. Individual differences: Have you considered that different students have different cognitive styles and learn at different rates?

8. Reinforcement technique: Intrinsic (personal success and self-approval...) or extrinsic (peer approval, tokens, grades...)?

C. EVALUATION

1. How will you know if learning objectives have been accomplished? How will the student know?

2. Will the student demonstrate transfer of the knowledge learned? How?

3. Is evaluation formal (tests, ditto sheets...) or informal (informal questioning, class participation...)?

Appendix C: Comparison Treatment Syllabus

Science Clinic

EDC&I 370: Course Expectations and Grading

You can think of the Science Clinic as consisting of both an Instructional Component and a Practicum Component. The Instructional Component includes reading assignments and your experiences in 210 Miller Hall during classtime. The Practicum Component includes your attempts to design, teach, and evaluate a science lesson in your field classroom sometime during the quarter. The grade you receive in the course will be determined by your performance in completing the following requirements of the two components.

Instructional Component

You will be expected to attend classes regularly and punctually, and participate fully in class activities. Working independently or in small groups, you will complete the assigned investigations and discuss your observations and results with others in the class. There will be four or five quizzes over the material presented in the the textbook and during classtime. The quizzes will account for 75% of your final grade.

Practicum Component

The Practicum Component report will account for the remaining 25% of your grade. To satisfy the requirements of the component, you will be expected to: (1) become familiar with the science program used in your field classroom, (2) plan and teach a science lesson, and (3) evaluate the effectiveness of the science lesson you taught. Your actual teaching will not be evaluated, so your grade for this component will be determined by the quality of the three activities listed above. Following are more details about the specific tasks of the Practicum Component.

<u>Task #1: Overview of the School Science Program</u>

Complete each of the following:

1. Provide a succinct description of the school science program, giving special attention to the philosophy, objectives, content, organization, expected teacher and student behavior, and student assessment techniques.

2. Quantify your analysis using a rating form such as the one on pages 275 and 276 of your textbook, or devise your own rating form. For guidance, refer to pages 272 through 277 of your textbook and to handouts provided in class. For science programs using a textbook, refer to the samples handed out in class.

3. Respond to these questions:

(a) Is the program regularly used in the school? Why or why not?

(b) How does your program differ from those described in chapter 9 of your textbook? In what ways are they similar?

(c) How does this program match with your personal orientation toward teaching?

Task #2: Lesson Planning

Though each teacher eventaully develops his or her own format for constructing lesson plans, certain elements are nearly always essential. This requirement is intended to help you focus on the critical elements of good lesson plans.

Complete each of the following:

1. Devlop a functional lesson plan for a science lesson you plan to teach in the field this quarter. For ideas regaring format, refer to "The Quick Check Lesson Planner" which is attached to this guide. Refer also to pages 285-291 and 294-298 in your textbook for help in selecting learning objectives and instructional strategies. To help me evaluate your lesson plan, indicate the grade level and class size with which you are working.

2. Analyze your lesson plan using the "Lesson Planning Sheet" which is attached to this handout. Before you teach your lesson, respond to each question on the planning sheet. For this one time only, write a brief response to each item (A.1 through C.3) and submit this along with your lesson plan.

Task #3: Instructional Evaluation

The professional growth of all teachers depends on honest self-appraisal. To help you evaluate the science lesson you taught, ask yourself each of the following questions and submit your written responses along with the other practicum requirements:

1. What were your feelings immediately after finishing the lesson?

2. Were learning objectives achieved? How do you know? How does the student know?

3. What student cues did you identify during the lesson which would indicate satisfaction or dissatisfaction with the experience?

4. What aspects of the lesson did you consider to be well planned and executed?

5. What aspects of the lesson would you change if you were to teach it again to a similar group of children? Why?

6. What assumptions did you make about the children and subject matter that proved to be valid? Invalid?

7. What kinds of management problems did you have, if any?

8. What kinds of discipline problems did you have, if any?

SUBMITTING THE PRACTICUM COMPONENT REPORT

Complete all of the listed requirements to your satisfaction and assemble the materials together in one report. Submit the report anytime prior to December 2, 1981.